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The realistic models of relativistic stars in f (R) = R + α R^2 gravity

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Abstract

© 2017 IOP Publishing Ltd. In the context of f (R) = R + αR 2 gravity, we study the existence of neutron and quark stars for various α with no intermediate approximation in the system of equations. Analysis shows that for positive α the scalar curvature does not drop to zero at the star surface (as in general relativity) but exponentially decreases with distance. Also the stellar mass bounded by star surface decreases when the value α increases. Nonetheless distant observers would observe a gravitational mass due to appearance of a so-called gravitational sphere around the star. The non-zero curvature contribution to the gravitational mass eventually is shown to compensate the stellar mass decrease for growing α's. We perform our analysis for several equations of state including purely hadronic configurations as well as hyperons and quark stars. In all cases, we assess that the relation between the parameter α and the gravitational mass weakly depends upon the chosen equation of state. Another interesting feature is the increase of the star radius in comparison with general relativity for stars with masses close to maximal, whereas for intermediate masses 1.4-1.6M ⊙ the radius of star depends upon α very weakly. Also the decrease in the mass bounded by star surface may cause the surface redshift to decrease in R2-gravity when compared to Einsteinian predictions. This effect is shown to hardly depend upon the observed gravitational mass. Finally, for negative values of αour analysis shows that outside the star the scalar curvature has damped oscillations but the contribution of the gravitational sphere into the gravitational mass increases indefinitely with radial distance putting into question the very existence of such relativistic stars.

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Keywords

modified gravity, neutron and quark stars, scalar-tensor theories

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